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FARMERS' BULLETIN 498.

METHODS OF EXTERMINATING THE TEXAS-FEVER TICK.

BY

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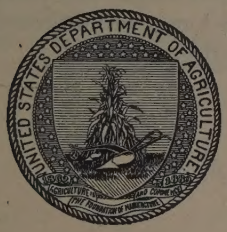

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., March 8, 1912.

Sir: I have the honor to transmit herewith a manuscript entitled "Methods of Exterminating the Texas-fever Tick," by Dr. H. W. Graybill, assistant zoologist in the Zoological Division of this bureau. This paper is a revision of Farmers' Bulletin 378, issued in 1909.

For many years these ticks, which transmit the disease of cattle known as Texas or tick fever, have been a cause of heavy loss and a great handicap to live-stock raising in the southern part of the United States. The progress so far made, however, in the cooperative campaign by this department and State authorities with the object of completely eradicating this pest from the country demonstrates that it is entirely possible to accomplish that result, although a number of years of hard work will be required. It is of great importance for the success of this undertaking that the efforts of the officials should be supplemented by individual work by the farmers. This paper gives simple and practical directions for exterminating the ticks, and I respectfully recommend its publication in the Farmers' Bulletin series.

Respectfully,

A. D. Melvin,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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METHODS OF EXTERMINATING THE TEXAS-FEVER TICK.

INTRODUCTION.

The eradication of the cattle tick (*Margaropus annulatus*) from the Southern States is a problem of prime importance to the agricultural interests of that section. The elimination of the tick would give a tremendous impulse to the cattle and dairy interests of the South, place southern agriculture on a more scientific and profitable basis, and, as a consequence, give a greater measure of prosperity to the South as a whole. Although the extermination of the tick would be of the greatest benefit to those States in which the tick now occurs, the benefits resulting therefrom would not be confined to them, but would be enjoyed to a greater or less extent by the rest of the country, in consequence of which the problem becomes, to a certain degree, one of national importance.

A number of valuable papers on the life history of the cattle tick, its habits, and methods for its eradication have been published by the United States Department of Agriculture and by various investigators in the States included within the infested region. Some of these publications are rather extensive and include much that is only of scientific interest, while others, of a more or less practical nature, are not available for general use. The present bulletin is prepared with the view of bringing together from these various sources information of practical value relating to the tick and its eradication, for the use of the farmer or stockman who has begun or who contemplates undertaking the complete extermination of this pest from his farm.

PROGRESS IN TICK ERADICATION.

During the past six years the Bureau of Animal Industry has been conducting tick-eradication work in all of the States of the infested region except one, in cooperation with the State authorities. During this time (from 1906 up to April 15, 1912) 162,648 square miles have been rendered free of ticks and relieved from the restrictions placed on infested territory by the national quarantine measures against splenetic fever, and in a considerable additional area the work of eradication is well under way. The area which has been rendered free exceeds the combined areas of the States of Georgia, Alabama,

and Mississippi. This record alone should be ample proof of the feasibility of ultimately eradicating the tick from the infested area, and is evidence of the efficacy of the methods adopted. The methods will undoubtedly be improved upon from time to time as new facts become available as a result of further investigations, but it may be stated that they have reached such a degree of perfection and have been given such a wide practical test, especially those that involve a treatment of the animals, that the question of how to eradicate ticks successfully is no longer an essential part of the problem, and the main part of the task is to enlist a hearty, vigorous, and conscientious cooperation on the part of the people. In other words, the work will progress from now on just as rapidly as the people desire that it should.

REASONS FOR ERADICATING THE CATTLE TICK.

There are various kinds or species of ticks occurring on cattle in the Southern States, but the one that chiefly concerns us here is that commonly called the "cattle" or "Texas-fever" tick (*Margaropus annulatus*). It is the one most frequently found on cattle, and is much more abundant than the other species. When the losses occasioned by this parasite are once thoroughly understood by farmers and stockmen there will be little need for arguments in favor of tick eradication. Some of the losses are not directly noticeable and consequently make little impression, while other losses properly chargeable to the tick are frequently attributed to other causes.

It is hardly necessary to emphasize the fact that the tick is something more than a simple parasite drawing blood from its host, it being the carrier of a dangerous microorganism, or germ, which it transmits to the blood of cattle, thus causing a disease known by many names, among which are Texas fever, tick fever, splenetic fever, and murrain.[1] Without the tick there can be no Texas fever, and it is by preventing the spread of the tick beyond its natural bounds that the fever has been prevented from waging destruction among northern cattle, which are especially susceptible to the disease. In order to restrict the distribution of the tick the National and State governments maintain a quarantine line extending across the country from the coast line of southern Virginia to the southern boundary of Texas, and also running across the southwestern part of California, marking the boundary between the States or portions of States harboring this pest and those that do not (fig. 1). Cattle of the quarantined area can not be driven across this line and may be shipped only in accordance with the regulations of the Secretary of Agriculture to prevent the spread of splenetic fever of cattle.

[1] For information as to this disease and how it is transmitted by the ticks the reader is referred to Farmers' Bulletin 258, "Texas or Tick Fever and Its Prevention."

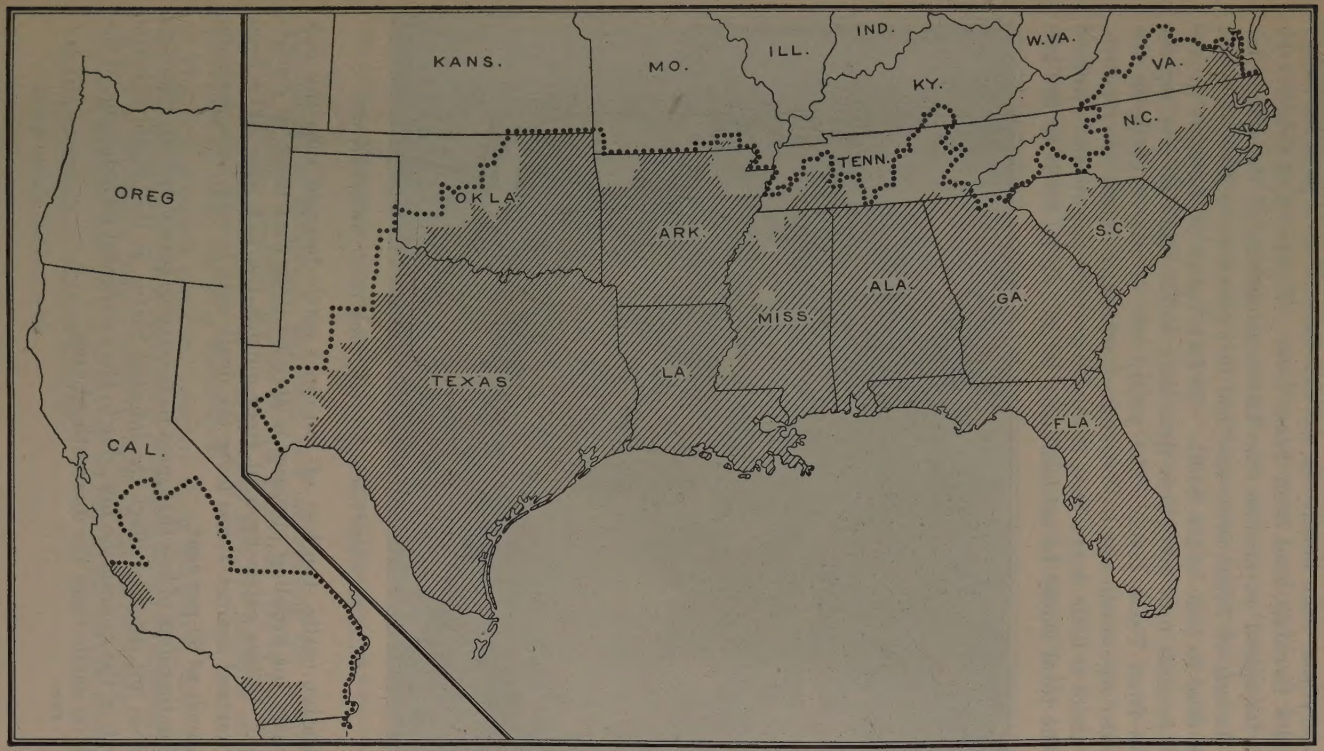

FIG. 1.—Map showing areas quarantined on account of Texas fever and areas freed from ticks. Shaded portions indicate areas under quarantine; dotted lines show boundary of infected area at beginning of tick eradication in 1906; white areas below dotted line indicate territory that has been freed from ticks and released from quarantine.

Every year each locality in the tick-infested area pays its toll to the tick in cattle dead from Texas fever. The truth of this is very soon impressed on anyone who knows something of the symptoms and lesions of Texas fever and has had occasion to observe cattle from time to time in the South. In fact, many of the more intelligent farmers now recognize that they suffer more or less regular losses from Texas fever. The yearly loss of native cattle in the infested region can not be determined with any degree of certainty, but there is little doubt that if the losses were known and summed up the total would be astonishingly large. In addition to the loss

FIG. 2.—Tick-infested steer before dipping, August 12, 1911; weight 730 pounds.

of native cattle, the loss of purebred cattle brought into the tick country for breeding purposes is another item that must be considered. Unless cattle brought from outside the tick area have been immunized against Texas fever the death rate is very high, reaching as much as 90 per cent.

Another item of loss that must be taken into consideration, although it does not directly affect the infested States, is the death of cattle north of the quarantine line, due to the accidental introduction of the tick on cattle from the quarantined area.

With regard to cattle that survive an attack of fever, it should be said that their growth and development are frequently arrested for some time following the attack, or even permanently arrested, resulting in the production of dwarfed or stunted animals that can not prove profitable to the owner. Even in the case of cattle that have survived an attack of Texas fever, whether they have suffered any great injury therefrom or not, the presence of any considerable number of ticks on them must be regarded as a great drain on the animal economy, increasing the amount of feed required by each animal and requiring a greater expenditure of energy on the part of

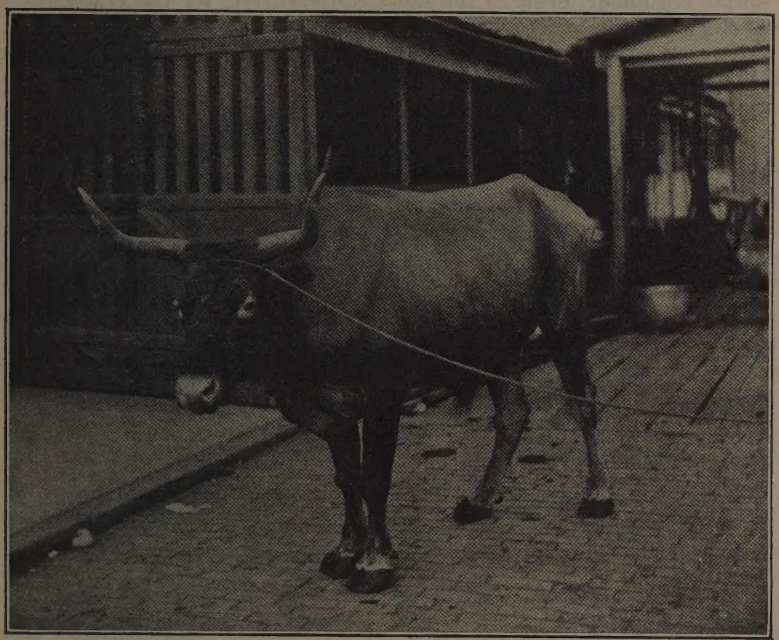

FIG. 3.—Same steer as shown in figure 2, October 12, 1911, two months after being freed of ticks; weight 1,015 pounds.

the animal in obtaining, digesting, and assimilating the additional food required. In consequence of this drain the rate of putting on flesh in the case of beef cattle is reduced and the amount of milk produced by dairy cattle is diminished.

The tick prevents southern breeders from exhibiting their cattle in the North and likewise prevents or interferes seriously with northern breeders exhibiting their purebred cattle in the infested area. The latter restriction has no doubt played an important part in retarding the improvement of southern cattle.

Another source of considerable loss is due to the lower price brought generally by southern cattle on the market because of the restrictions placed on them. In addition to this there should be noted the expense incurred by transportation companies in conforming to the regulations governing the interstate movement of cattle from the infested region and that incurred by the Federal Government and the infested States in establishing quarantine lines and enforcing regulations to prevent the spread of Texas fever.

The total annual loss due to the tick has been estimated by various writers at $40,000,000 to $100,000,000. These figures should be ample argument, even to the most conservative, for the eradication of the tick.

The South needs more and better live stock and a larger and better dairy industry, and these objects would both be greatly promoted by the destruction of the tick. Furthermore, the increased production of live stock, by reason of its important bearing in maintaining and improving the fertility of the soil, would be of distinct benefit in increasing the yield of field crops. An incidental, though important, advantage of stock raising and dairying would be found in the distribution of the farmer's income throughout the year, enabling him to live on a cash basis. It can thus be seen that the benefits which would accrue to southern agriculture from the extermination of the cattle tick would be very great and far-reaching.

An example of the benefits of tick eradication is afforded by the Mississippi steer shown in figures 2 and 3. This steer when infested with ticks weighed only 730 pounds on August 12, 1911. He was freed of ticks by dipping on that date, and two months later (Oct. 12) his weight had increased to 1,015 pounds. The feed in the meantime was the same as before. The steer thus gained 285 pounds in two months after being freed of ticks, an average daily gain of $4\frac{3}{4}$ pounds.

LIFE HISTORY OF THE TICK.

Before methods of eradication can be carried out intelligently and successfully it is necessary to know the life history of the tick and the influence of temperature, moisture, and other climatic conditions on the various stages of its existence. These matters will therefore be taken up first, it being understood that whenever the term "tick" or "cattle tick" is used it refers to the one species or kind, *Margaropus annulatus*.[1]

Cattle are the usual hosts for this tick. Frequently, however, horses, mules, deer, and sometimes even buffaloes and sheep serve as hosts. But none of these latter animals, with the possible exception

[1] The reader desiring fuller information as to the life history of the cattle tick is referred to Bulletin 72, of the Bureau of Entomology, and Bulletin 130, Bureau of Animal Industry, U. S. Department of Agriculture, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15 and 10 cents, respectively.

of deer and buffaloes, are susceptible to tick fever, consequently they suffer from the tick as a simple parasite and not as a transmitter of disease, although they must be considered in plans for eradication.

Only a part of the development of the tick takes place on the host; the rest of the development occurs on the pasture occupied by the host.

DEVELOPMENT ON THE GROUND.

In tracing the life history of the cattle tick it will be convenient to begin with the large, plump, olive-green female tick (fig. 4), about half an inch in length, attached to the skin of the host. During the few preceding days she has increased enormously in size, as a consequence of drawing a large supply of blood.

When fully engorged she drops to the ground, and at once, especially if the weather is warm, begins to search for a hiding place on moist earth beneath leaves or any other litter which may serve as a protection from the sun and numerous enemies or shield her from unfavorable conditions. The female tick may be devoured by birds, or destroyed by ants, or may perish as the result of unfavorable conditions, such as low temperature, absence or excess of moisture, and many other conditions; so that many which fall to the ground are destroyed before they lay eggs.

Egg laying (see fig. 5) begins during the spring, summer, and fall months in from 2 to 20 days, and during the winter months in from 13 to 98 days, after falling to the ground. The eggs are small, elliptical-shaped bodies, at first of a light amber color, later changing to a dark brown, and are about one-fiftieth of an inch in length. As the eggs are laid they are coated with a sticky secretion which causes them to adhere in clusters and no doubt serves the purpose of keeping them from drying out. During egg laying the mother tick gradually shrinks in size and finally is reduced to about one-third or one-fourth her original size. Egg laying is greatly influenced by temperature, being retarded or even arrested by low temperatures. It is completed in from 4 days in the summer to 151 days beginning in the fall. During this time the tick may deposit from a few hundred to more than 5,000 eggs. After egg laying is completed the mother tick has fulfilled her purpose and dies in the course of a few days.

After a time, ranging from 19 days in the summer to 188 days during the fall and winter, the eggs begin to hatch. From each egg issues a small, oval, six-legged larva or seed tick (fig. 6), at first amber colored, later changing to a rich brown. The seed tick, after crawling slowly over and about the shell from which it has emerged, usually remains more or less quiescent for several days, after which it shows great activity, especially if the weather is warm, and ascends the nearest vegetation, such as grass, other herbs, and even shrubs.

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FIGS. 4 to 10.—Cattle ticks in various stages. 4. Full-grown female tick, engorged and ready to drop to ground and deposit eggs. (Magnified 3 times.) 5. Tick laying eggs. One tick may lay as many as 5,000 eggs. (Magnified 3 times.) 6. Larvæ or seed ticks after emerging from eggs. (Magnified 8 times.) 7. Young ticks before (*a*) and after (*b*) first molt. At this stage the ticks have attached themselves to a host (cow, steer, etc.) and have changed from a brown color to white. It will be noticed that the tick has six legs before molting and eight afterwards. (Magnified 9 times.) 8. Young tick nearly ready to undergo the second molt. The tick at this stage is known as a nymph. (Magnified 8 times.) 9. Male tick. (Magnified 8 times.) 10. Female tick after second molt. This tick is now sexually mature and slightly larger than the male, but will later greatly increase in size until ready to drop to the ground and deposit eggs. (Magnified 8 times.)

Since each female lays an enormous mass of eggs at one spot, thousands of larvæ will appear in the course of time at the same place and will ascend the near-by vegetation and collect on the leaves and other parts of plants. This instinct of the seed ticks to climb upward is a very important adaptation to increase their chances of reaching a host. If the vegetation upon which they rest is disturbed they become very active and extend their long front legs upward in a divergent position, waving them violently in an attempt to seize hold of a host.

The seed tick during its life on the pasture takes no food and consequently does not increase in size, and unless it reaches a host to take up the parasitic portion of its development, it dies of starvation. The endurance of seed ticks is very great, however, as they have been found to live nearly eight months during the colder part of the year.

DEVELOPMENT ON CATTLE.

The parasitic phase of development begins when the larvæ or seed ticks reach a favorable host, such as a cow. They crawl up over the hair of the host and commonly attach themselves to the skin of the escutcheon, the inside of the thighs and flanks, and to the dewlap. They at once begin to draw blood and soon increase in size. In a few days the young tick changes from a brown color to white (fig. 7, *a*), and in from 5 to 12 days sheds its skin. The new form has eight legs instead of six and is known as a nymph (fig. 7, *b*, and fig. 8).

In from 5 to 11 days after the first molt the tick again sheds its skin and becomes sexually mature. It is at this stage that males and females are with certainty distinguishable for the first time. The male (fig. 9) emerges from his skin as a brown, oval tick, about one-tenth of an inch in length. He has reached his growth and goes through no further development. He later shows great activity, moving about more or less over the skin of the host. The female (fig. 10) at the time of molting is slightly larger than the male. She never shows much activity, seldom moving far from her original point of attachment. She still has to undergo most of her growth. After mating the female increases very rapidly in size, and in from 21 to 66 days after attaching to a host as a seed tick she becomes fully engorged (fig. 4) and drops to the pasture, to start again the cycle of development by laying eggs.

SUMMARY OF LIFE HISTORY.

To sum up, on the pasture there are found three stages of the tick—the engorged female, the egg, and the larva or seed tick; and on the host are also found three stages—the larva or seed tick, the nymph, the sexually mature adult of both sexes, and in addition the engorged condition of the female.

METHODS OF ERADICATION.

In undertaking measures for eradicating the tick it is evident that the pest may be attacked in two locations, namely, on the pasture and on the cattle.

In freeing pastures the method followed may be either a direct or an indirect one. The former consists in excluding all cattle, horses, and mules from pastures until all the ticks have died from starvation. The latter consists in permitting the cattle and other animals to continue on the infested pasture and treating them at regular intervals with agents destructive to ticks and thus preventing engorged females from dropping and reinfesting the pasture. The larvæ on the pasture, or those which hatch from eggs laid by females already there, will all eventually meet death. Such of these as get upon the cattle from time to time will be destroyed by the treatment, while those which fail to find a host will die in the pasture from starvation.

Animals may be freed of ticks in two ways. They may be treated with an agent that will destroy all the ticks present, or they may be rotated at proper intervals on tick-free fields until all the ticks have dropped.

PASTURE ROTATION.

TIME REQUIRED TO KILL TICKS BY STARVATION.

The time required for the ticks to die out after all animals have been removed from infested fields and pastures varies considerably, depending principally on the climate and the weather. The dates when pastures will be free of ticks, beginning during each month of the year, are given in the following table:

TABLE I.—*Time required to free pastures from ticks by starvation.*

Date of removal of all animals from pasture.	Date when pasture will be free from ticks.	Date of removal of all animals from pasture.	Date when pasture will be free from ticks.
July 1	March 1.	December 15 to March 15, inclusive	September 1.
August 1	May 1.	April 1	September 15.
September 1	July 1.	April 15	October 15.
October 1 to November 1, inclusive	August 1.	May 1 to June 15, inclusive	November 1.
December 1	August 15.		

The above table is based on investigations by Hunter and Hooker [1] at Dallas, Tex., and by the writer [2] at Auburn, Ala., under cooperation between the Bureau of Animal Industry and the veterinary department of the Alabama Polytechnic Institute. All the periods obtained by Newell and Dougherty (1906) [3] in work carried on at Baton Rouge, La., which is much farther south, are shorter. The

[1] Bulletin 72, Bureau of Entomology, U. S. Department of Agriculture.
[2] Bulletin 130, Bureau of Animal Industry, U. S. Department of Agriculture.
[3] Circular 10, State Crop Pest Commission of Louisiana.

periods given in Table I should be found ample for all localities lying no farther north than Dallas, Tex., or Auburn, Ala.

In general, moisture and cold prolong and dryness and heat shorten the duration of an infestation. If various portions of the same pasture differ with regard to temperature and moisture, as is frequently the case, some parts become free of ticks before others do. Other things being equal, high, dry, unshaded land becomes tick free sooner than low, damp, shady land. Land, however, that is supplied with an excessive amount of moisture and is extremely shady, as along some river bottoms, is not likely to be a favorable breeding place for the cattle tick, and low lands that are subjected to more or less regular overflows, if infested at all, are, as a rule, only lightly infested.

The time required for freeing pastures in the southern part of the infested area may be considerably less in many localities than that indicated in Table I, yet, in view of the fact that we are not in possession of ample data as to what the lengths of periods should be, the simplest and safest plan will be to follow the table in the region indicated for it. There is little doubt that the periods are longer for the majority of localities in the northern half of the infested area. Mr. E. C. Cotton[1] obtained at Knoxville, Tenn., during the years 1907 to 1909, inclusive, periods considerably longer than those given in Table I. Table II is based on the records obtained at Knoxville.

TABLE II.—*Time required to free pastures from ticks by starvation.*

Date of removal of all animals from pasture.	Date when pasture will be free from ticks.	Date of removal of all animals from pasture.	Date when pasture will be free from ticks.
January 1	August 1.	June 15	May 1.
February 1 to March 15	November 15.	July 1	June 15.
April 1 to 15	January 1.	July 15	July 1.
May 1	January 15.	August 1 to 15	July 15.
May 15 to June 1	February 15.	September 1 to October 1	September 15.

While there can be little doubt that the periods are considerably longer at Knoxville than farther south, it is likely that the above periods are much more than ample for the starvation of ticks under natural conditions. It appears that the work at Knoxville has been conducted by using incubation tubes provided with sand and regularly supplied with moisture. It has been found in our experiments in which such tubes, and also field plots representing natural conditions, were utilized in studying the tick, that the periods obtained with the tubes are longer than those occurring under natural conditions. The above table is given, however, for those living in the northern half of

[1] Bulletin 94, Agricultural Experiment Station of the University of Tennessee.

the infested region who may desire to use periods that undoubtedly are ample.[1]

According to experiments conducted by Mr. Cotton,[2] the normal duration of an infestation may be considerably shortened or even suddenly brought to an end in infested pastures and fields by the occurrence of exceptionally low temperatures. He found that a certain per cent of engorged females are destroyed by a temperature of 23° F., that all engorged females are destroyed by a temperature of 14° F. when not provided with a protective covering, and that ticks provided with a covering of dry chaff were able to survive a temperature of 12° F., but if the covering is wet they are killed as readily as when unprotected. It was also found that ticks that have deposited some eggs are much more readily destroyed than those that have not begun to oviposit. In addition to this it was demonstrated that all unprotected eggs and all seed ticks are destroyed at temperatures of 4° and 2° F., respectively, but that eggs protected by dry litter can endure a much colder temperature. It is thus seen that the infestation of fields may be greatly reduced during cold spells and may, if the temperature falls to about zero, be entirely destroyed. In case the temperature falls only to a point where all the females are destroyed, the only result accomplished will be a shortening of the period of infestation.

It would be well for stock owners to take advantage as far as practicable of cold spells in which zero weather occurs in freeing their places of ticks. It should be remembered, however, in doing this, that cattle even during the coldest weather are likely to harbor ticks and these will be unaffected by the low atmospheric temperature. These ticks when they drop will reinfest the place; consequently, when a spell of zero weather occurs, if the cattle are not on the fields, pastures, or ranges they should not be returned to the same until freed of ticks, or if at pasture they should be removed at once and not returned until rendered free of ticks by one of the methods suggested later in this bulletin.

TIME REQUIRED TO FREE CATTLE OF TICKS ON UNINFESTED FIELDS.

Before discussing plans for rendering farms tick free, involving the use of the information given in Table I, it will be necessary to indicate how animals may be entirely freed from ticks by placing them on uninfested fields. This is based on the fact that the female tick

[1] In the same bulletin, Part II, in which Mr. Cotton's results are given (Bulletin 94, Agricultural Experiment Station of the University of Tennessee), Mr. J. F. Voorhees, under the title of "Relation of climate to life history," has published periods beginning with the 1st of each month of the year for 27 localities in the tick-infested area, and has given a map for each month of the year, having lines running through localities possessing periods of approximately the same duration. Such data would be of great value in tick eradication, but since the validity of the method used by Mr. Voorhees has not been satisfactorily established, it is not thought wise to include his results at this time.

[2] Loc. cit.

must drop from the host to the ground before eggs can be laid and before young ticks will develop.

The shortest time in which seed ticks will appear after engorged females have been dropped is 20 days. Consequently, cattle placed on a tick-free field during the warmer part of the year are not in danger of becoming infested again with young ticks until 20 days have elapsed. The time required for all the ticks to drop after cattle have been placed on uninfested land varies with the temperature. It is much longer during the winter than during the summer. The time required, beginning at various times of the year, is given in Table III.

TABLE III.—*Time required for all ticks to drop from cattle placed on tick-free land.*

When ticky cattle are placed on tick-free land during	All ticks will have dropped in—	When ticky cattle are placed on tick-free land during—	All ticks will have dropped in—
August	Six weeks.	March	Seven weeks.
September	Do.	April	Six weeks.
October	Eight weeks.	May	Do.
November	Nine weeks.	June	Do.
January	Ten weeks.	July	Five weeks.
February	Seven weeks.		

FREEING CATTLE OF TICKS BY ROTATION ON TICK-FREE LAND.

The plan of freeing cattle of ticks by rotating them from one lot or field to another is as follows: Beginning at any time of the year from March to September, inclusive, in the southern half of the infested area, the cattle are removed from the tick-infested pasture they have been occupying to a tick-free lot or field and continued there for not more than 20 days. During this time a considerable number of ticks will drop. In order to prevent the cattle from becoming reinfested (by seed ticks resulting from eggs laid by females that have dropped), the herd is then changed to a second tick-free inclosure for 20 days longer, and if they are not free of ticks by that time, they are placed in a third tick-free inclosure for 20 days more. Should the two changes at intervals of 20 days have been made, 60 days will have elapsed, which is ample time for all ticks to have dropped during the portion of the year indicated, and the animals are ready to be placed on a tick-free pasture or field without danger of becoming reinfested. The periods to free cattle (given in the above table) are believed to be ample. It will, however, be a wise precaution to make a careful examination of the cattle for ticks before placing them in the noninfested field they are to occupy.

During the part of the year from October to February, inclusive, the time required for seed ticks to appear after females have dropped is much longer than the time necessary for all the ticks to drop from

cattle. Consequently, if it is desired, the herd may be continued on the same field for the required length of time without danger of becoming reinfested. (According to the data obtained at Knoxville, the period during which cattle may be placed on tick-free land to drop all their ticks without danger of reinfestation is somewhat longer than for the southern part of the infested region, extending from September to March, inclusive, instead of from October to February, inclusive.)

In Table IV the approximate dates when ticky cattle will be in danger of reinfestation when placed on tick-free land at various times of the year have been given. The first section will probably apply to most localities in the southern half of the infested region, and the second section to localities having temperature conditions approximately the same as at Knoxville, Tenn.

TABLE IV.—*Dates seed ticks will appear after ticky cattle have been placed on tick-free land.*

BASED ON DATA OBTAINED AT BATON ROUGE, LA., AUBURN, ALA., AND DALLAS TEX.

Date cattle placed on tick-free pastures.	Date seed ticks will appear.
Jan. 1 to Feb. 4, inclusive	Apr. 24.
Mar. 3	May 3.
Apr. 15	May 20.
May 1	June 5.
June 5	June 28.
July 1	July 25.
Aug. 5	Aug. 30.
Sept. 1	Oct. 7.
Oct. 1	Feb. 25.
Nov. 1 to Dec. 15, inclusive	Mar. 3.

BASED ON DATA OBTAINED AT KNOXVILLE, TENN.

Jan. 11 to Mar. 4, inclusive	May 29.
Apr. 1	June 3.
May 15	June 20.
June 12	July 19.
July 3	Aug. 2.
Aug. 6	Sept. 6.
Sept. 4	Apr. 14.
Oct. 2	May 20.

FREEING BOTH CATTLE AND PASTURES OF TICKS BY THE ROTATION METHOD.

The particular scheme of rotation to be followed on a farm depends much on the conditions which have to be met. In figures 11 to 14 four plans of rotation are represented.[1] In these diagrams no attempt has been made to indicate, except in a very rough way, the relative size of the fields, since this depends on the number of cattle and on various conditions of a more or less local nature. It rests with the farmer to select his fields with regard to location and size so as to carry out properly and successfully the plan which he adopts.

[1] These plans are based on the periods given in Table I, and are therefore applicable only to the region covered by that table.

The dissemination of ticks requires brief attention before taking up the consideration of rotation methods. Although this seems to be of much importance when considered from a theoretical standpoint, in practice it does not assume the same degree of importance. It seems to be the general opinion of those engaged in the actual tick-eradication work that ticks are not often spread from field to field or from farm to farm except through the agency of ticky animals. It will, nevertheless, be well to record the possible ways in which ticks might be spread from farm to farm, in order that precautions may be taken against this in cases in which it seems especially desirable or necessary to do so.

It is known from experimental work that engorged females and seed ticks do not crawl more than a few feet on a pasture, yet if they should happen to be near a dividing fence they might crawl from one pasture or field to another. Seed ticks might in certain instances during heavy winds be blown across a dividing line from one pasture to another, and it is conceivable that occasionally engorged ticks might drop from the heads of animals reaching through a dividing fence. The danger of ticks being disseminated in these ways may be practically eliminated by constructing a double fence with an intervening space of 15 feet. It is possible that at times dogs, cats, and other animals which ordinarily pass unhindered over farms may carry seed ticks, that have temporarily lodged on their coats, from field to field. The danger, however, of ticks being spread in this way is in all probability very slight.

It is entirely possible for engorged females, eggs, and seed ticks to be carried from a pasture by running water and lodged in another place without being injured in any way. The danger from this source is probably greatest where there are many small streams subject to frequent floods of short duration and on hillsides where the water runs off with great force during heavy rains.

Plan requiring four and one-half months.—The plan of rotation represented in figure 11 requires four and a half months for its completion. Some time during the spring the pasture is divided in the middle by two lines of temporary fence 15 feet apart. The herd is first confined in field No. 1A. On June 15 it is removed from this portion of the pasture to the other portion, designated field No. 1B, and on September 2 is moved to field No. 2A. The cattle are permitted to remain 20 days on each of the fields designated 2A, 2B, and 3. At the end of this time (Nov. 1) all the ticks on the cattle have dropped, and the herd is returned to field No. 1A, which in the meantime has become free of ticks. Later, if it is desired, the cattle may be placed in field No. 4. They should not, however, be returned to any of the other fields or driven across them, since these are infested

with ticks. Field No. 1B will be free from ticks July 1 of the following year, at which time the temporary double fence may be removed and the cattle allowed to graze over the entire pasture. The rest of the farm will be free of ticks by August 1. If found desirable, the herd may be continued longer in field No. 3, even as late as February

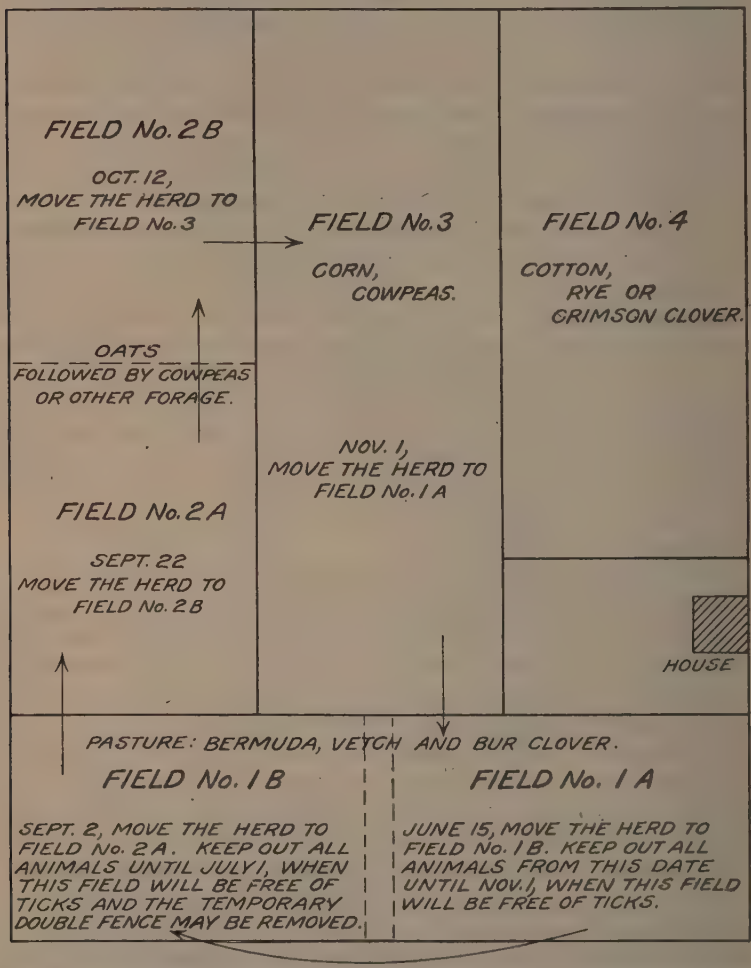
FIELD No. 2B
OCT. 12, MOVE THE HERD TO FIELD No. 3
FIELD No. 3
CORN, COWPEAS.
FIELD No. 4
COTTON, RYE OR CRIMSON CLOVER.
OATS FOLLOWED BY COWPEAS OR OTHER FORAGE.
NOV. 1, MOVE THE HERD TO FIELD No. 1A
FIELD No. 2A
SEPT. 22 MOVE THE HERD TO FIELD No. 2B
HOUSE
PASTURE: BERMUDA, VETCH AND BUR CLOVER.
FIELD No. 1B
FIELD No. 1A
SEPT. 2, MOVE THE HERD TO FIELD No. 2A. KEEP OUT ALL ANIMALS UNTIL JULY 1, WHEN THIS FIELD WILL BE FREE OF TICKS AND THE TEMPORARY DOUBLE FENCE MAY BE REMOVED.
JUNE 15, MOVE THE HERD TO FIELD No. 1B. KEEP OUT ALL ANIMALS FROM THIS DATE UNTIL NOV. 1, WHEN THIS FIELD WILL BE FREE OF TICKS.

FIG. 11.—Plan for freeing cattle and pastures from ticks by rotation, requiring four and one-half months.

15, the only objection to this being that it will break the crop rotation by preventing the sowing of oats in the fall.

It is well, when practicable, to have double fences with an intervening space between the different fields in order to prevent the ticks getting from one field to another. If this is not possible on account

of the expense and time required to build the extra line of fence, the next best thing to do is to throw up several furrows with a plow on each side of the dividing fences.

When there are streams running through the farm or the slope of the land is considerable, so that ticks may be washed from one field

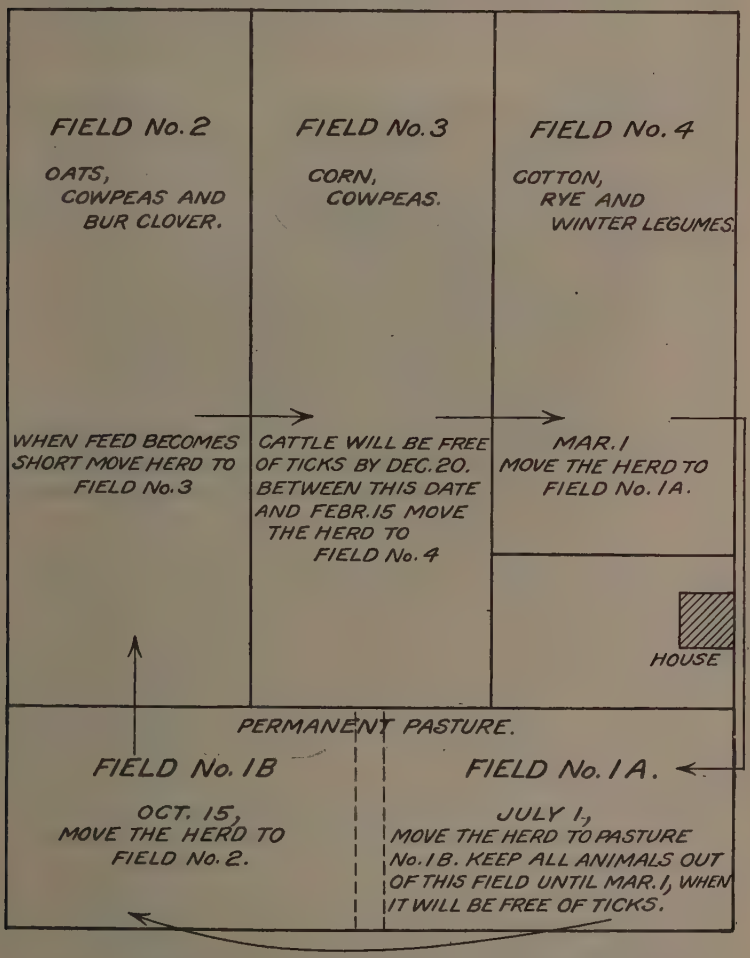
FIELD No. 2
OATS, COWPEAS AND BUR CLOVER.
FIELD No. 3
CORN, COWPEAS.
FIELD No. 4
COTTON, RYE AND WINTER LEGUMES.
WHEN FEED BECOMES SHORT MOVE HERD TO FIELD No. 3
CATTLE WILL BE FREE OF TICKS BY DEC. 20. BETWEEN THIS DATE AND FEBR. 15 MOVE THE HERD TO FIELD No. 4
MAR. 1 MOVE THE HERD TO FIELD No. 1A.
HOUSE
PERMANENT PASTURE.
FIELD No. 1B
OCT. 15, MOVE THE HERD TO FIELD No. 2.
FIELD No. 1A.
JULY 1, MOVE THE HERD TO PASTURE No. 1B. KEEP ALL ANIMALS OUT OF THIS FIELD UNTIL MAR. 1, WHEN IT WILL BE FREE OF TICKS.

FIG. 12.—Plan for freeing cattle and pastures from ticks by rotation, requiring eight months.

to the other during rains, the fields should be so arranged or selected that the drainage is from field No. 1A to No. 1B, and from field No. 3 toward fields Nos. 2A and 2B.

Plan requiring eight months.—The plan indicated in figure 12 is begun 15 days later than the preceding one and requires eight months

for its completion. The pasture is divided as before. The herd is moved July 1 from field No. 1A to No. 1B, and on October 15 is moved from there to field No. 2. The herd may be continued on fields Nos. 2 and 3 until February 15 in any way found most convenient, since there is no danger of young ticks hatching during that time. The herd is moved not later than February 15 to field No. 4. All the ticks on the cattle will have dropped by December 20, consequently the herd may be moved to field No. 4 as early as that date, if found desirable.

By March 1 the original pasture is free and the cattle are returned there. Field No. 1B will be free of ticks by August 1, at which time the double fence separating the two parts of the pasture may be removed. The rest of the farm will not be certainly free of ticks until September 1. The drainage in general should be from field No. 1A toward No. 1B, and from field No. 4 toward field No. 2.

Plan requiring four months, with a new pasture.—The plan of rotation represented in figure 13 involves changing the location of the pasture. The oat field (field No. 4) after the grain has been harvested is reserved for this purpose. It should be sown in cowpeas, Bermuda grass, and bur clover. The herd is moved October 15 from the original pasture, field No. 1, to field No. 2, where it may be kept for a month or two, or until the feed becomes short, then moved to field No. 3, where it is kept until February 15, when it is moved to the new pasture, field No. 4. The old pasture may be planted in oats. The drainage should be from field No. 4 toward field No. 2.

The feed-lot or soiling method, requiring four and one-half months.—In the plan given in figure 14, the feed-lot or soiling method is made use of to free the cattle of ticks. In the spring field No. 3B, located near the farmyard, is sown in corn for a soiling crop. The area devoted to corn should be sufficient to supply feed for the herd for five or six weeks. Field No. 3A, after the oats are harvested, should be sown in sorghum and cowpeas or millet and cowpeas, and should be large enough to furnish feed for the herd until November 1. These fields should not have had cattle on them for at least 10 months.

Previous to June 15 three lots, each large enough to accommodate the herd, are fenced off in field No. 3B. These lots should not be located on a stream, and the drainage should be from field No. 3A toward field No. 3B. There should be a space of 15 feet or more between the lots. On June 15 the herd is moved to lot No. 1, and afterwards to lots Nos. 2 and 3 at intervals of 20 days. After the cattle have spent the required time in lots Nos. 1 and 2, if it is found, after a careful examination made by some one familiar with such work, that the cattle are free of ticks, they may be turned directly into field No. 3A. If they are not free they should be placed in lot No. 3 until

they are free, or, if this can not be determined with certainty, until 15 or 20 days more have elapsed, which will be much longer than necessary for all ticks to drop during July and August.

If desirable, the corn in each lot may be cut and removed before the cattle are placed in it. As soon as possible after the cattle are

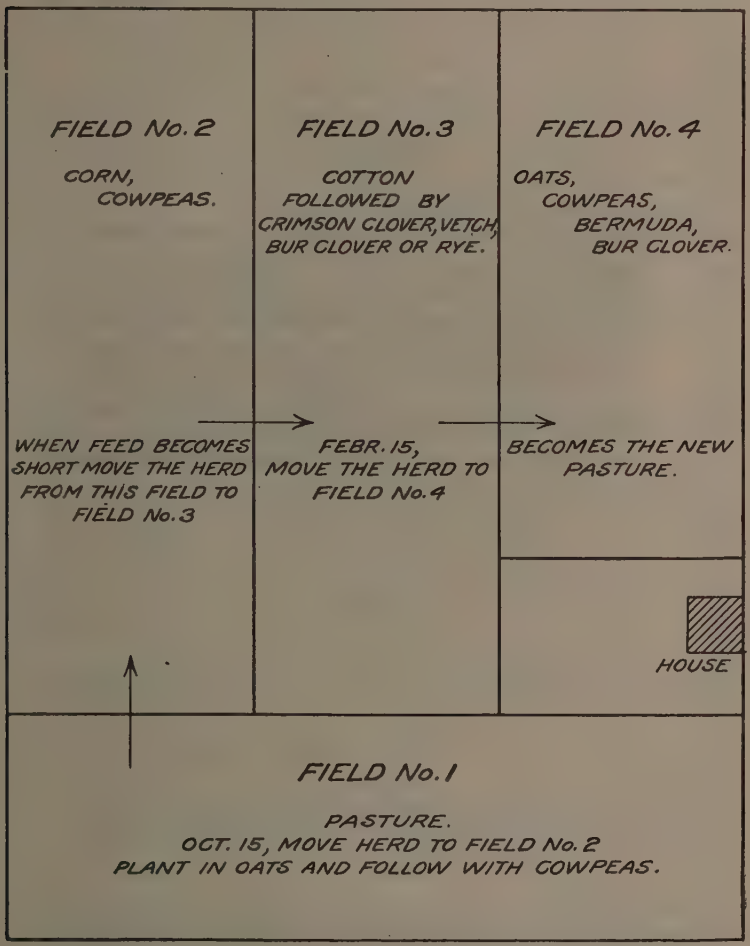
FIELD No. 2
CORN, COWPEAS.
FIELD No. 3
COTTON FOLLOWED BY CRIMSON CLOVER, VETCH, BUR CLOVER OR RYE.
FIELD No. 4
OATS, COWPEAS, BERMUDA, BUR CLOVER.
WHEN FEED BECOMES SHORT MOVE THE HERD FROM THIS FIELD TO FIELD No. 3
FEBR. 15, MOVE THE HERD TO FIELD No. 4
BECOMES THE NEW PASTURE.
HOUSE
FIELD No. 1
PASTURE.
OCT. 15, MOVE HERD TO FIELD No. 2
PLANT IN OATS AND FOLLOW WITH COWPEAS.

FIG. 13.—Plan for freeing cattle and pastures from ticks by rotation, requiring four months, with a new pasture.

removed from a lot the female ticks and the eggs present on the ground should be plowed under and the ground along the fence sprayed with crude petroleum or some other disinfectant to prevent any seed ticks which may hatch from getting beyond the area of the lot. Another

valuable precaution will be to use for feed, as far as possible, the corn opposite or in advance of the lot in which the cattle are located, since this is less likely to harbor seed ticks.

The pasture will be free of ticks by November 1, and the cattle may then be returned there if desired. The herd may, however, be

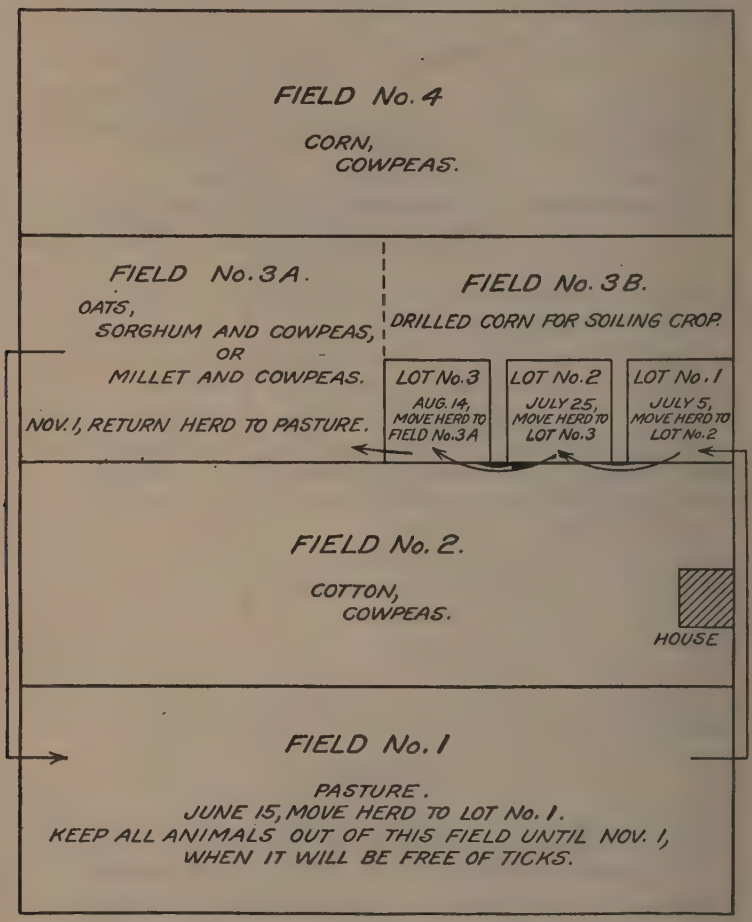

FIG. 14.—Plan for freeing cattle and pastures from ticks by rotation; feed-lot or soiling method.

continued on field No. 3A as long after that date as the forage lasts, or, in case of a shortage of feed previous to November 1, it may be moved to either field No. 2 or 4, provided one of these is ready for pasturage. These fields may be used for fall and winter pasturage in any way that may be found desirable.

DIPPING, SPRAYING, AND HAND DRESSING.

Ticks upon cattle may be destroyed by using various tick-destroying agents such as oils and arsenic. These may be applied in three ways, namely, by hand, by the use of spray pumps, and by means of the dipping vat.

Hand application is practicable only when a few animals are to be treated. The substances of value in this method are a mixture of lard and kerosene, cottonseed oil, or a half-and-half mixture of cottonseed oil and kerosene, and finally, crude petroleum, which in general has proved the most effective, although it has some drawbacks, chief of which are the difficulty of obtaining oil of the proper quality, its bulk, which makes its transportation costly, and the liability of injury to cattle when the treatment is applied in hot weather. Any of these preparations may be applied with a mop or a good-sized paint brush, but unless great pains are taken this method of treatment is not thorough, and even at the best some portions of the body where ticks may be located will be missed. This method of application should be resorted to only when for some reason other methods would be found impracticable.

Spraying is adapted for small-sized herds. The arsenical mixture and crude petroleum or emulsions of the same may be applied by means of an ordinary pail spraying pump (fig. 15). There are also pumps on the market designed for making a temporary mechanical mixture of oil and water. Cottonseed oil, or cottonseed oil and kerosene in a half-and-half mixture, or crude petroleum, may be used in these pumps, and a 20 per cent mixture of any one of these will kill most of the ticks. A large spraying machine which is now on the market and which has met with considerable favor in the treatment of large herds of cattle for mange is equally adapted to the application of remedies for ticks, but on account of its expense is not likely to come into general use.

The dipping vat on the whole is the best and cheapest means of applying remedies when large herds are to be treated. The great advantage of dipping over spraying or hand treatment lies in the fact that the thoroughness of the treatment under all conditions is practically assured, not being dependent to any degree on the care exercised by those in charge of the work. The substances usually used in dipping vats are crude petroleum and arsenical dips. Crude petroleum is no longer used to any great extent, and has been replaced by arsenical dips, which have proved more satisfactory in every respect.

CRUDE PETROLEUM.

Various kinds of crude petroleum have been used with more or less success in destroying ticks. The heavier varieties of oil are very injurious to cattle. On the other hand, the very light oils are so

volatile that their effects last but a short time, thus rendering them less efficient. The petroleum known as Beaumont oil, obtained from Texas wells, has given the best results. The best grade of this oil to use is one that has a specific gravity ranging from 22½° to 24½° Beaumé, containing 1¼ to 1½ per cent of sulphur, and 40 per cent of the bulk of which boils between 200° and 300° C. The oil may be applied by hand or by employing a spray pump or a dipping vat.

Animals that have been dipped in crude oil, especially during warm weather, should not be driven any great distance immediately afterwards, and should be provided with shade and an abundance of water. Unless these precautions are observed serious injury and losses may result.

Emulsions of crude petroleum.—Instead of plain crude petroleum an emulsion of crude petroleum, preferably Beaumont crude petroleum, may be used. The use of the emulsion makes the treatment less expensive than when the oil alone is used. The emulsion is not so injurious to the cattle and is almost if not quite as effective as the oil alone. The formula for preparing an emulsion of crude petroleum is as follows:

Hard soap	pound..	1
Soft water	gallon..	1
Beaumont crude petroleum	gallons..	4

making 5 gallons of 80 per cent stock emulsion.

When a greater quantity of stock emulsion is desired each of the quantities in the above formula should be multiplied by such a number as to furnish the required amount. For example, if it should be convenient to mix 10 gallons at one time, the quantities would have to be multiplied by 2, and if 15 gallons were desired, they would have to be multiplied by 3, and so on.

In preparing the emulsion the soap should be shaved up and placed in a kettle or caldron containing the required amount of water. The water should be brought to a boil and stirred until the soap is entirely dissolved. Enough water should be added to make up for the loss by evaporation during this process. The soap solution and the required amount of oil are then placed in a barrel or some other convenient receptacle and mixed. The mixing may be effected by the use of a spray pump, pumping the mixture through and through the pump until the emulsion is formed. A convenient and time-saving method is to do the mixing in a barrel by first pouring in one part of hot soap solution and then four parts of crude petroleum and repeating this until the barrel is filled. The oil should be poured in with as much force as possible and the mixture stirred constantly with a long paddle until the oil is completely emulsified. The mixing is facilitated also by dipping up the mixture and pouring it back with a pail.

If made properly this stock emulsion is permanent and will keep indefinitely.

To prepare the stock emulsion for use it is diluted with water to a 20 or 25 per cent emulsion. In order to obtain a 20 per cent emulsion of oil it is necessary to use one part of the stock emulsion to three parts of water, and for a 25 per cent emulsion one part of stock emulsion to two and one-fifth parts of water. The stock emulsion is permanent, but the diluted emulsion does not remain uniformly mixed, so that if allowed to stand it should be thoroughly mixed by stirring before using. Only rain or soft water should be used for diluting, and if this is not available the water should be "softened" by adding a sufficient amount of concentrated lye, sal soda, or washing powder. Care should be observed in this process not to use an excess of these preparations.

ARSENICAL DIPS.

Arsenical dips as agents for destroying cattle ticks have come into much favor during the past few years. This has been due to their efficacy, cheapness, the ease with which they are prepared, and the comparatively slight injury they cause to cattle when properly prepared and used. Homemade dips are the ones most commonly used and are quite satisfactory in every way when ordinary care is used in their preparation. Recently there has been placed on the market a proprietary concentrated arsenical dip which has given good results. This dip is prepared for use by diluting it with cold water in the proportions of 1 to 100. The only advantage in such a dip is that comparatively little time is required in preparing the bath, but this advantage is largely counterbalanced by the fact that it is more expensive than a homemade dip.

The formula most commonly used in making an arsenical dip is the following:

Sodium carbonate (sal soda)	pounds..	24
Arsenic trioxid (white arsenic)	do....	8
Pine tar	gallon..	1
Water sufficient to make 500 gallons.		

If for any reason a stronger dip is desired, 25 pounds of sodium carbonate and 10 pounds of arsenic trioxid may be used in place of the amounts given in the above formula. The stronger dip is required by the regulations of the Bureau of Animal Industry in the dipping of cattle which are to enter interstate commerce from quarantined areas, but for ordinary eradication work when immediate removal of the cattle to tick-free areas is not contemplated it will probably be best to use the weaker solution, and this is especially true during hot weather and when the animals are to be treated every two weeks.

In preparing the dip a large caldron or galvanized tank is required for heating the water in which to dissolve the chemicals. Twenty-five gallons of water should be placed in the caldron or tank and brought to a boil. The amount of sodium carbonate indicated in the formula is then added and dissolved by stirring. When this is accomplished, the required amount of arsenic is added and dissolved in a similar manner. The fire is then drawn, and the solution permitted to cool to 140° F., or this process may be hastened by the addition of cold water. The pine tar is then added slowly in a thin stream and thoroughly mixed with the solution by constant stirring. This solution should be diluted at once to 500 gallons.

If a large enough caldron or tank is available for preparing the dip a greater quantity of solution may be prepared at one time, always, of course, in the same proportions as the above. In this way the time required in preparing the amount of solution necessary to fill a vat is reduced considerably. In case it is necessary to use a smaller container, say of about the capacity of 15 gallons, only half the amount of solution indicated should be prepared at one time, the quantities of ingredients used being half those in the formula. This, however, will require so much time in preparing the amount of solution necessary to fill a vat that when possible it is advisable to provide a larger vessel for dissolving the chemicals.

The caldron or tank and utensils used in preparing the dip should be kept free from grease or oil, as small quantities of these may envelop particles of arsenic and prevent or hinder the solution of the arsenic. It should also be borne in mind that when hard water is used in the preparation of the dip the dissolving of the sodium carbonate (sal soda) in the boiling water results in the formation of a fine white or gray insoluble powder or precipitate of lime salts which may be taken for undissolved arsenic, and thus lead to the belief that all of the arsenic has not gone into solution.

The arsenical solution when prepared according to the above method should be diluted as soon as the pine tar has been added, in order that the tar may become properly emulsified. In the concentrated solution the tar tends to separate out, especially when the solution becomes cold, and collect in a layer at the bottom of the container. Even when the plan of immediately diluting the solution is followed a satisfactory emulsion is not always obtained, and some of the tar may separate and go to the bottom of the vat.

If, however, the acids present in the tar are neutralized by the use of concentrated lye a good emulsion of the tar in the diluted dip may be obtained.[1] The neutralization is effected by dissolving 1 pound of concentrated lye in a quart of water for every gallon of tar to be

[1] This method for emulsifying the tar has been suggested by the Biochemic Division of the Bureau of Animal Industry.

used and adding this solution to the tar, stirring thoroughly. When the acids of the tar have been properly neutralized the resulting mixture should be a bright, thick fluid of a dark-brown color. Whether the acids have been neutralized or not may be determined by taking a small quantity of the tar on the blade of a pocket knife or on a sliver of wood and stirring it in a glass of water. If the acids have been neutralized the tar will mix uniformly with the water; whereas, if they have not been neutralized, the tar will float about in the water in the form of various-sized globules that will settle to the bottom when the agitation of the water ceases. For all ordinary grades of tar one pound of lye to the gallon will be ample to effect neutralization, but if on testing it is found that this amount has not been sufficient, it will be necessary to add more lye solution, about a pint at a time for each gallon, until the test shows that the acids have been neutralized. The neutralized tar should be added to the diluted arsenical dip and not to the concentrated solution with which it will not mix satisfactorily. When the neutralized tar is used the vat should be filled with diluted arsenic-soda solution prepared in the usual way. The required amount of neutralized tar, diluted with two to three times its volume of water, should then be added to the solution in the vat and thoroughly mixed with the same by stirring.

Before filling a vat the capacity at the depth to which it is necessary to fill it for dipping, if not known, should be calculated, and for future convenience the water line should be plainly marked at some point on the wall of the vat. Unless this is done it will be necessary either to calculate the amount of water in the vat each time it is filled or measure it as it is placed in the vat, both of which procedures will consume considerable unnecessary time. The most convenient way to get the water into the vat is to conduct it through pipes, either directly from a pump or from an elevated tank used for storing water for farm purposes. Frequently, however, it is not possible to bring the water to the vat through pipes, and it becomes necessary to resort to the laborious process of hauling it in barrels on wagons or sleds.

In case the pine tar is added to the concentrated solution when it is made, in which case, as already stated, it is necessary to dilute the solution at once, the vat should be partly filled with water and then the arsenical solution added as it is made. For example, if the vat holds 2,000 gallons, about 1,500 gallons of water should be placed in the vat, then four times the amount of solution for making 500 gallons of dip should be prepared and mixed with the water, after which the vat should be filled to the 2,000-gallon mark. Within certain limits it is immaterial just how much water is added at first, provided, of course, ample allowance is made for the volume of the concentrated dip so that when it is added the dip line will not come above the mark to which the vat is to be filled.

The capacity of the vat planned in this bulletin, at a depth of 5 feet 3 inches, is 1,470 gallons. In order to fill it to that depth with dip it will be necessary to prepare two batches of concentrated dip, each containing the ingredients necessary for making 500 gallons of diluted dip, and a third batch containing 7 pounds 9 ounces of arsenic and 22 pounds 3 ounces of sodium carbonate in case 8 pounds of arsenic are being used to the 500 gallons, or 9 pounds 7 ounces of arsenic and 22 pounds 8 ounces of sodium carbonate in case 10 pounds of arsenic are being used to the 500 gallons.

A stock arsenical solution is found convenient for replenishing the dip in a vat when it has gotten too low for dipping and in cases in which spraying is regularly done on a farm, and also in eradication work when it is necessary for inspectors to carry a supply of arsenical dip from farm to farm for use in spraying. In the latter case it is especially desirable that the stock solution be of a high concentration because of the limited amount of space available for carrying the required amount of dip. A stock solution in which the ingredients for 500 gallons of dip are dissolved in 25 gallons of water will probably meet the requirements in most instances. In making up the stock solution the arsenic and sal soda for 500 gallons should be dissolved in the usual manner in 25 gallons of water. The tar should not be added to the stock solution. Special care should be observed to see that the solution after boiling and cooking measures 25 gallons, and any deficiency due to evaporation during boiling should be made up by adding cold water. Nineteen parts of water to one part of this solution will give the proper dilution. The tar, neutralized in the manner already described, should be mixed with the solution after it has been diluted, in the proportion of about half a pint for every 30 gallons of diluted dip.

In diluting stock solutions great care should always be used in measuring the amount of solution and water used. A small error in measuring the amount of stock solution required is likely to cause a considerable variation in the arsenic content of the dip, especially if the quantity prepared is small. If the variation happens to be in the direction of too low a percentage of arsenic, the treatment may not prove effective, whereas if it happens to be in the other direction cattle that are treated may be injured or even killed. Care is especially necessary in the case of a certain highly concentrated proprietary dip to be used at a dilution of 1 to 100. In using this great care should be observed in measuring the amount required, and the dilution recommended of 1 to 100 should be strictly followed.

The arsenical dip may be left in the vat and used repeatedly, replenishing it with the proper quantities of water and stock solution when necessary. When, however, the dip becomes filthy through the

addition of manure and dirt carried in by the cattle, the vat should be emptied, cleaned, and filled with fresh fluid. The frequency with which this should be done must be left to the owner, as the condition of the dip at any period after it has been made depends on a variety of conditions, such as the number of cattle dipped, the frequency of the dippings, etc. Even though the dip may not become very filthy, its efficacy decreases somewhat on standing, owing to gradual oxidation of the arsenic. It is therefore advisable to recharge the vat at intervals irrespective of the condition of the dip as to cleanliness.[1]

In order that dipping in arsenic may be both efficacious in destroying ticks and also harmless to the cattle at all times, it is of the highest importance that the dip be of the proper strength when made and that it be maintained as far as practicable at that strength. Due care in making the dip and in calculating the capacity of the vat will of course assure the correct initial strength of the dip. Providing the vat with a waterproof cover will do much to maintain the dip at its proper strength by preventing on the one hand concentration by evaporation and on the other hand dilution by rains. A cover will also reduce the risk of cattle being poisoned during the intervals between dippings, especially when the vat is not protected by a fence. During rains the water from the draining pen or chute should not be permitted to run into the vat and dilute the dip.

At the conclusion of each dipping, especially if the vat is without a cover, it is well to mark the position of the surface of the dip on the side of the vat in order to determine at the next dipping whether there has been a change in the level of the dip. If the surface of the dip has fallen and it is known that the vat does not leak, there has been a loss of water by evaporation and consequently an increase in the strength of the dip. In order to bring the dip down to its former strength water should be run into the vat until the dip surface reaches the mark made at the last dipping. If the fall has been due to the vat leaking, the strength of the dip has not been altered and consequently water alone should not be added. If the dip surface has been raised by rain the amount of water added in this way should be determined by calculation, and for every 19 of water 1 gallon of the stock solution previously mentioned should be used.

Precautions in the use of arsenic.—Because of the fact that arsenic is a poison great pains should be taken in caring for it after it is purchased from the druggist, in order that persons and animals may not be accidentally poisoned. The dip at the time it is being made

[1] Mr. R. M. Chapin, of the Biochemic Division, has invented a portable test case for testing arsenical dips in the field, which has been shown to be a practical success after extensive field tests. With this device it is now possible to ascertain quickly the strength of the dip in a vat and thus determine when the vat should be recharged. It is the intention of the bureau to place test outfits in the hands of its men engaged in tick eradication.

and also after it is diluted should be handled and protected as a poison. Unless such precautions are observed accidents are certain to occur. When, however, arsenic is handled with the proper care there is no more danger in its use on the farm than in the use of a number of other poisons that are commonly and regularly employed by farmers for destroying insect pests of plants and obnoxious rodents.

Persons using the dip, especially with the spray pump, should not subject their hands and other portions of the body, by permitting their clothing to become wet, to the action of the dip any more than is necessary, and it is well to wash the hands well after each spraying, especially when they are frequently subjected to the dip. At the time the dip is being prepared care should be observed not to inhale the vapor arising from the caldron or kettle, and during spraying the same precaution should be exercised against the inhalation of the spray.

In making the dip, weights and measures should not be guessed at, and the arsenic, especially, should be weighed with the greatest care.

Cattle should always be watered a short time before they are dipped. After they emerge from the vat they should be kept on a draining floor until the dip ceases to run from their bodies; then they should be placed in a yard free of vegetation until they are entirely dry. If cattle are allowed to drain in places where pools of dip collect from which they may drink, or are turned at once on the pasture, where the dip will run from their bodies on the grass and other vegetation, serious losses are liable to result. Crowding the animals before they are dry should also be avoided, and they should not be driven any considerable distance within a week after dipping, especially in hot weather. If many repeated treatments are given, the cattle should not be treated oftener than every two weeks.

In addition to properly protecting vats containing arsenical dip when not in use another precaution must be observed when vats are to be emptied for cleaning. The dip should not be poured or allowed to flow on land and vegetation to which cattle or other animals have access. The best plan is to run the dip into a pit properly protected by fences. The dip should also not be deposited where it may be carried by seepage into wells or springs which supply water used on the farm.

Dalrymple and Kerr[1] have suggested a method of rendering the arsenical dip harmless by the use of air-slaked lime and copperas (ferrous sulphate). This method should not, however, be used alone, but rather as a precautionary measure supplementary to the plan suggested above for disposing of the dip.

[1] W. H. Dalrymple and A. P. Kerr, Bulletin 132, Louisiana Agricultural Experiment Station.

The process consists in using 6 pounds each of air-slaked lime and copperas to each 100 gallons of dip to be treated. The required amount of lime is first added to the dip and thoroughly mixed with it by stirring. After this treatment the dip should be permitted to stand for at least an hour. The copperas should then be dissolved in hot water and the solution while still hot should be added slowly to the dip and well mixed with the same by stirring. The dip should then be permitted to stand for at least 12 hours, after which it may be removed from the vat and disposed of in the way suggested.[1]

PROCEDURE IN DIPPING AND SPRAYING.

Whether dipping or spraying is employed in eradicating ticks from a farm, the method of procedure is the same. In undertaking eradication, all the cattle, and also the horses and mules in case they harbor ticks, are treated regularly every two or three weeks, during the part of the year that the temperature is favorable to treatment, until the ticks have disappeared from the farm. The purpose of the treatment is to destroy all ticks that get on the animals before they have had a chance to mature and drop, and thus prevent them from reinfesting the pasture and other portions of the farm. If the treatment used were absolutely effective in destroying each and every tick on the animals treated there would be no renewal of the infestation on the farm after the treatment is begun, and the cattle would act simply as collectors of ticks which would be destroyed regularly by the treatment applied every two or three weeks. It is likely, however, that in most instances, either because of the lack of efficacy of the dip or imperfect application, or both, some ticks escape treatment and reproduce on the pasture, resulting in prolonging the time that would otherwise be required for eradication.

If ticks apparently disappear from the cattle after they have been under treatment for some time, the dipping or spraying should not be discontinued until it has been determined by a number of careful hand inspections that the cattle are free of ticks. If ticks continue on cattle until cold weather and then finally disappear it should be borne in mind that in all probability eradication has not been accomplished and that there may be engorged females, unhatched eggs, and inactive seed ticks on the farm, and that even if the cattle should remain free of ticks during the winter they may become reinfested the following spring. In any case in which ticks disappear from the cattle and treatment is discontinued the cattle should be watched

[1] The Biochemic Division is at present investigating the process proposed by Dalrymple, together with other possible processes for attaining the same end. The essential part in the process is played by caustic lime which, when present in excess, precipitates all but practically inappreciable traces of the arsenic as insoluble calcium arsenite. It is therefore desirable to use quicklime in place of the air-slaked lime recommended by Dalrymple, slaking it with water in the usual manner before adding to the dip, while the addition of ferrous sulphate appears to be unnecessary.

with the greatest care for ticks until ample time has elapsed to leave no doubt that the farm is free of ticks.

After a farm has been freed of ticks precautions should be observed to prevent ticks from being reintroduced on the place. In case it becomes necessary to bring cattle to the farm from ticky farms they should be completely freed of ticks before being brought on the place; or, if this is not possible, a quarantine lot or pen should be set aside on the farm to be used exclusively for ticky cattle, where such cattle may be kept and entirely freed of ticks before being placed with the other cattle. Such cattle may be freed of ticks by dipping them twice at an interval of 7 to 10 days in an arsenical dip containing 10 pounds of arsenic to the 500 gallons. After the second dipping the cattle should not be placed in the quarantine pen, but placed in a tick-free lot, where they may be observed for a time to see that the treatment has been entirely effective, after which they may be placed with the other cattle, if desired.

FIG. 15.—Dipping cattle.

In dipping, each animal should be completely submerged in the dip, and to prevent any animals going through the vat without becoming wet all over with the dip a man should be stationed at the middle of the vat with a forked stick to shove those under that may have failed to be completely submerged. (See fig. 15.)

Dipping, as a rule, will be found more satisfactory in every way than spraying. The treatment requires much less time and, as a rule, will be found much more effective. In many cases, however, where the number of cattle on a farm is small, it is not economical to construct a dipping vat. In such cases if there is a sufficient number of cattle within a radius of several miles to warrant the construction of a vat, it will be advisable for the farmers to cooperate in constructing a vat where all of the cattle of the community may be dipped. In case the construction of a community vat is impracticable, it will then be necessary to resort to spraying or hand dressing.

In spraying animals, a good type of pail spray pump (fig. 16), costing from $5 to $7, will probably be found most satisfactory. It should be provided with about 15 feet of ⅜-inch high-pressure hose and a type of nozzle furnishing a cone-shaped spray of not too wide an angle. A nozzle with a very small aperture should not be used, because the spray produced is too fine to wet properly the hair and skin of the animals without consuming an unnecessary amount of time.

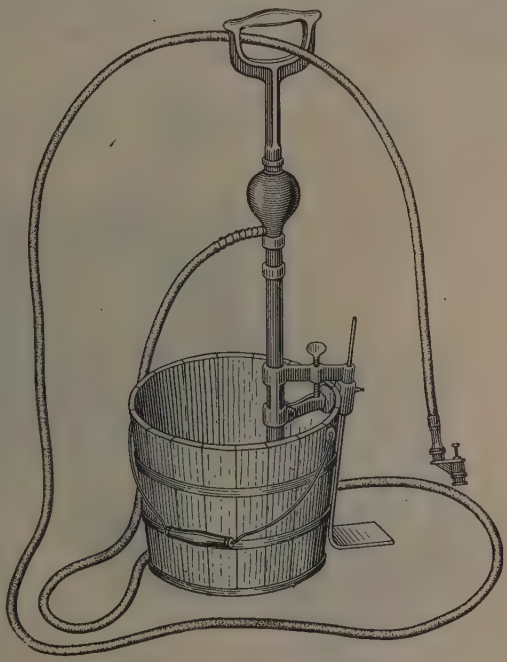

FIG. 16.—Pail spraying pump for small herds.

In spraying animals the work should be done with great thoroughness. The animal to be sprayed should be securely tied to a post, or, better still, to one of the posts of a board or rail fence or in a fence corner, where it can not circle about to avoid the treatment. Every portion of the body should be thoroughly treated, special attention being given to the head, dewlap, brisket, inside of elbows, inside of thighs and flanks, the tail, and the depressions at the base of the tail. An animal can not be satisfactorily sprayed unless it is restrained by tying or some other means, and results can not be obtained unless the hair and skin are thoroughly wetted.

In some instances a large oil can with a hole cut in the top (fig. 17) for the admission of the spray pump has been used in place of an ordinary bucket. Such a can has the advantage that animals can not drink from it, and if it is permitted to stand unguarded, as is likely to occur at any time during the operation of spraying a herd, there is no danger of animals being poisoned by drinking the dip.

A convenient arrangement in handling the nozzle during spraying is to tie it loosely by its base to the end of a stick about 3 feet long (fig. 18). By moving the stick rapidly back and forth the spray may be caused to vibrate, and by various manipulations of the hose in relation to the stick the spray may be readily directed in any direction.

FIG. 17.—Oil can used with spraying pump.

RULE FOR CALCULATING THE CAPACITY OF A DIPPING VAT.

The following rule has been adapted by Dr. B. H. Ransom from a mathematical formula for calculating the volume of a prismoid:

(1) Reduce all dimensions to the same denomination, feet or inches.

(2) Add the length of the bottom of the vat to the length at the water line.

(3) Add the width of the bottom to the width at the water line.

(4) Multiply these sums (2) and (3) together.

(5) Multiply the length of the bottom by the width of the bottom.

(6) Multiply the length at the water line by the width at the water line.

(7) Add together (4), (5), and (6).

(8) Multiply this sum (7) by one-sixth the perpendicular depth from the water line to the bottom, which gives the capacity of the vat in cubic feet or cubic inches.

(9) If the capacity in cubic inches has been obtained, divide (8) by 231; if the capacity in cubic feet has been obtained, divide (8) by 0.1336. In either case the result will be the capacity of the vat in gallons.

This method is mathematically accurate if the vat is set level, but if it is set so that it is slightly lower at one end than at the other, as is usual, the true capacity can not be obtained by this method. If, however, the figures for the width at the water line and the depth are taken from measurements at the middle of the vat the results obtained will vary only very slightly from the actual capacity.

SPECIFICATIONS FOR THE CONSTRUCTION OF A CONCRETE CATTLE-DIPPING VAT.[1]

Site.—The site selected for the location of the vat should be dry and of sufficient size to admit of the construction of the chute, the dripping pen, and at least two additional pens—one for holding the cattle prior to dipping and the other for retaining them after dipping until sufficiently dried.

Excavation.—The excavation should be made 1 foot wider and 1 foot longer than the inside dimensions of the vat and should conform to its shape. The inside dimensions of the vat are shown on the drawings (fig. 19) and are as follows: Length at top of vat, 26 feet; bottom, 12 feet. Width at top, 3 feet; at bottom, 1½ feet. Depth, 6½ feet.

The sides and bottom of the excavation should be firm and solid, as they are to serve for the outside forms in casting the concrete.

FIG. 18.—Convenient method of holding nozzle in spraying.

If it is necessary to do any filling in order to conform to the shape of the vat, the filling should be puddled and thoroughly rammed until solid, because the stability of the concrete depends on the foundation.

Forms.—The wooden forms should be constructed of 1-inch boards and 2 by 4 inch braces, the boards being nailed to the outside face of the braces, as shown in the drawings. The sides and end walls should be built 8 inches higher than the surface of the ground, which should be level.

Concrete.—The concrete should be made of one part of cement, by measure, two and one-half parts of sand, and five parts of broken rock or gravel. The cement should be of a standard brand of Portland, the sand clean and coarse, and the broken rock from about ¼-inch pieces to not larger than will pass in every direction through a 1-inch ring.

[1] Taken from Circular 183, Bureau of Animal Industry.

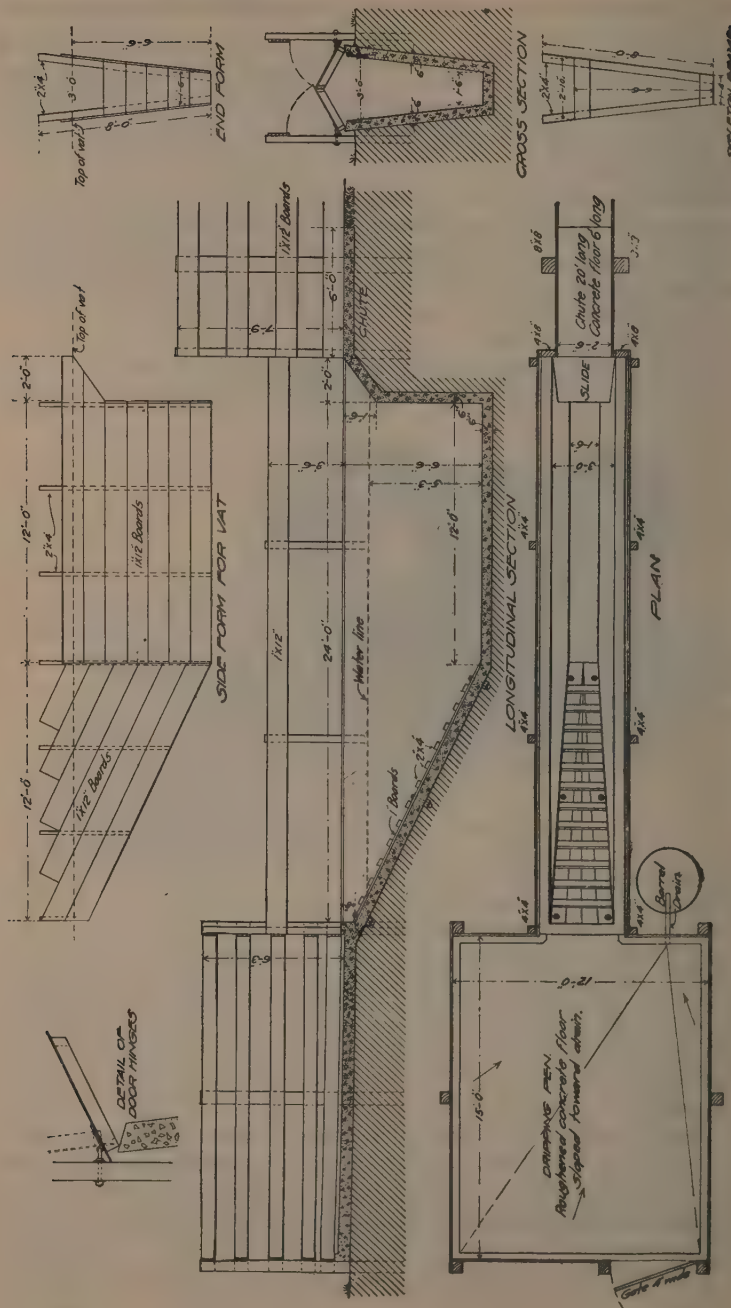

FIG. 19.—Plans for a concrete dipping vat.

Mixing.—The mixing should be done on a tight wooden platform or in a tight box. The sand and stone should be measured in a bottomless box, 2½ feet long by 2 feet wide by 1 foot deep, having a capacity of 5 cubic feet. A convenient size of batch to mix is one consisting of two bags of cement, one measure (5 cubic feet) of sand, and two measures (10 cubic feet) of stone.

The sand is measured out first and the cement emptied on top, after which the two materials are thoroughly mixed together, dry. In the meantime the stone may be measured out and thoroughly drenched with water. The cement-sand mixture is mixed with water and the resulting mortar then combined with the stone. The stone should be shoveled on the mortar, which has been previously spread out in a thin layer. Mixing should continue until the stone is thoroughly coated with mortar, more water being added during the mixing process if necessary.

Laying.—Before laying the concrete the molds should be set and thoroughly braced into place. The side forms may be suspended in the excavation with their lower edges 6 inches from the bottom by means of crosspieces nailed to the uprights and of sufficient length to rest on supports located several feet from the edges of the excavation. The concrete for the bottom and incline is deposited first, this mixture being of a consistency that water will flush to the surface on ramming. The mixtures for the sides and end should be very wet and should be thoroughly puddled into place. The consistency of the concrete for the side walls should be such that it will run off the shovel unless handled quickly.

The laying of the concrete should be done, if possible, in one operation, in order that there may be no joints between the new and old work. If it becomes necessary to lay the concrete on two or more days, the surface on which the new concrete is to be deposited should be washed thoroughly clean and coated with grout of pure Portland cement and water mixed to the consistency of cream. The new concrete should be placed before the grout has set. Extreme care should be taken to prevent dirt from falling in on top of the deposited concrete.

The forms should not be removed until the concrete is set, which in moderate weather will have taken place in about 24 hours. In damp, cold weather at least 48 hours should be allowed before removin the forms. It will be advisable, especially in water-soaked ground, to allow the forms to remain in place for one week before removal.

Finishing coat.—Before applying the surface coat, dampen the walls and floor thoroughly. Cover the entire exposed surface of the floor and walls with a coating one-half inch thick of cement mortar composed of Portland cement 1 part, sand 2 parts. Coating to be floated and troweled to a smooth finish.

Waterproofing.—If the earth around the vat is thoroughly drained the vat may be waterproofed by painting the surface coat, but painting the surface will not give satisfactory results if there is ground water to seep in. The paint may be good hot pine tar, or gas-house tar cut with naphtha or gasoline and applied with a brush, or after the mortar coat has hardened the inside of the vat may be painted with an oil-cement paint made as follows:[1] Mix enough water with Portland cement to make a fairly stiff paste; add to this 5 per cent of heavy petroleum residuum oil based on the weight of the cement, and mix thoroughly until the oil entirely disappears, then add more water and stir until a paint of the consistency of cream is formed. This paint should be applied with a brush and should be well rubbed into the surface. Should the mortar coat be omitted the paint coat should be applied directly to the surface of the concrete.

Exit incline.—As the exit incline is to have a false wooden floor, it will be necessary to embed iron bolts in the concrete, to which the wooden floor may be fastened. Before the concrete incline is laid, embed in the dirt three pieces of 2 by 4-inch scantling, placed at the top, center, and bottom of the incline. The bolts should extend through these pieces and should be placed with the head next to the dirt. The bolts should be long enough to extend through the concrete and the inch boards of the floor, so that the wooden floor may be securely fastened.

Slide.—Cover the slide with a sheet of boiler iron properly fastened to the cement.

Cover.—The cover of the vat consists of two leaves hinged on posts set 3 feet in the ground along each side of the vat. The leaves are 2 feet 6 inches wide, and when open rest against the upper part of the posts to which they are hinged and serve as splash boards. The details of the hinge[2] used and the method of setting it are shown in the drawings. When the leaves are open their lower edges are just above the top of the side walls, which are given a slope inward for the purpose of conducting the dip running from the splash boards back into the vat. Removable doors should be constructed to close the triangular openings left at the ends of the vat when the cover is closed. The hinges may be made by a blacksmith.

Dripping pen.—Construct a dripping pen about 12 by 15 feet at the head of the exit incline. The floor should be of concrete prepared as previously described for the vat and laid in a similar manner.

[1] These directions for the oil-cement paint are furnished by the Office of Public Roads of the U. S. Department of Agriculture.

[2] This hinge and the method of setting it for the cover of a dipping vat have been copied from an article by William Taylor Heslop in the Agricultural Journal of the Union of South Africa, Pretoria, vol. 1, No. 1, 1911, pp. 38–43.

The floor should be pitched toward a corner of the pen, where a pipe should be laid in the floor to carry the drippings into a barrel sunk in the ground. The drippings thus caught may be returned to the vat after settling. The floor should be roughened to prevent the cattle from slipping.

Chute.—The chute leading to the vat should be built 30 inches wide and 20 feet long, and the receiving and retaining pens should be of a size to take care of the animals to be dipped.

Bill of materials for vat, dripping pen, and chute.

LUMBER FOR FORMS.

8 pieces 1 by 12 inches by 14 feet long.
13 pieces 1 by 12 inches by 12 feet long.
2 pieces 1 by 12 inches by 9 feet long.
2 pieces 1 by 12 inches by 6 feet long.
2 pieces 1 by 12 inches by 4 feet long.
8 pieces 2 by 4 inches by 8 feet long.
2 pieces 2 by 4 inches by 7 feet long.
2 pieces 2 by 4 inches by 6 feet long.
2 pieces 2 by 4 inches by 4 feet long.
2 pieces 2 by 4 inches by 2 feet long.
7 pieces 1 by 6 inches by 12 feet long for crosspieces for inside of forms.

LUMBER FOR DRIPPING PEN.

7 pieces 6 by 6 inches by 10 feet long for posts.
10 pieces 1 by 8 inches by 16 feet long for side rails of pen.
5 pieces 1 by 8 inches by 12 feet long for side rails of pen.
5 pieces 1 by 8 inches by 8 feet long for side rails of pen.
The covers can be made from the lumber used in making the forms, and the lumber for the exit incline can be gotten in the same way.
The 4 by 4-inch posts to which the cover is hinged may be made from 2 by 4 stuff by spiking together.
End form to be made solid.

HARDWARE AND IRONWORK.

Six bolts, ½ by 10 inches, with nuts and washers, for false floor of incline.
One sheet of ¼-inch boiler iron cut to shape of slide; plate bored and countersunk for four screws.
Four pairs hinges for covers.
Three heavy T hinges and screws for gate of dripping pen.
One heavy iron bolt to fasten gate.

CONCRETE.

VAT.

Cement, 10½ barrels (42 bags).
Sand, 3¾ cubic yards.
Stone, 6¼ cubic yards.

DRIPPING PEN AND CHUTE.

Cement, 5½ barrels (22 bags).
Sand, 1¾ cubic yards.
Stone, 3½ cubic yards.

A 26-foot vat has been used extensively for eradication purposes with satisfactory results. However, if it is desired to lengthen the body of the vat on account of large numbers of cattle to be treated, or to make it conform to the bureau's requirements for the treatment of cattle for movement as noninfectious, there should be added to the amount of concrete material for each linear or running foot, cement, 0.37 barrel; sand, 0.12 yard; stone, 0.24 yard.

By some a dripping chute is regarded more satisfactory than a dripping pen. One of the advantages that it has is that the cattle are held in line in the order in which they have been dipped, thus making it possible to remove one or more of them at a time as soon as they have drained sufficiently in order to make room for others. In using the dripping pen this is not practicable, and it is necessary to wait until the last animal dipped has drained sufficiently and then remove them all together.

In case it is desired to construct a dripping chute it should be located at the head of the exit incline in line with the vat. It should be about 36 inches wide. The length will depend on the number of cattle it is desired to accommodate at one time, it being necessary to allow 4 to 5 feet for each. A length of from 20 to 40 feet is considered a convenient size for small herds. The floor should be made of concrete and sloped toward the vat. The dip should not be permitted to run directly into the vat, but should be collected in a barrel to settle, as shown in the case of the dripping pen. The floor at the sides should be raised about 2 inches in the form of a curb to keep the dip from running off.

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